Leaflet 16

Using solar energy in schools

Solar energy can provide free natural ventilation, daylight and heat. Its effective use in refurbishment and new buildings can:

- create a quality interior,
- reduce fuel bills, and thus minimise global environmental impacts.

Nabbotts Junior School showing natural ventilation through a classroom to the atrium

Passive solar design

Every school will want to achieve a good and healthy classroom environment in which pupils can concentrate. For this, it is essential to have effective ventilation and lighting all the year round, and heating in the winter. Schools are also looking for ways to run themselves more efficiently and save money. Using energy more efficiently is an obvious way of doing so.

Well known measures, like better insulation and up to date controls on heating systems, will be familiar to school managers. Less familiar is passive solar design which exploits daylight, natural ventilation and solar heating. These can be used to save the school money and to create an attractive working environment.

Passive solar design exploits the building's orientation, shape, materials, windows, internal room arrangement and the external landscaping, in combination with other energy efficiency measures, to create a pleasant working environment which is less dependent on fossil fuel based energy.

Unlike some energy efficiency measures, for example, heating or lighting controls, which are renewed periodically, most passive solar measures, like orientation, are fundamental to a building and cannot be changed. Others, like window size, are unlikely to be changed more than once in the life of a building, if at all. Schools should therefore ensure that their consultants are briefed to consider passive solar design in their proposals, along with other energy efficiency measures, right from the start of any scheme.

Opportunities for exploitation

The design of a new extension or new building offers the greatest scope for passive solar measures, but there are also opportunities in refurbishment schemes, or even in the annual maintenance budget. For example, a well insulated rooflight can be added during roof renewal to bring daylight into the interior of a room and improve ventilation. Windows which admit excessive solar heat in summer can be shaded with permanent or moveable external blinds or louvres or, if the site allows it, by planting deciduous trees.

To be successful, passive solar measures need to be integrated with other energy efficiency measures rather than considered in isolation. For example, if lights remain on when there is sufficient daylight, or if the heating is still on when solar gains suffice to raise the temperature to its desired level, then ‘free’ solar energy does not save energy nor the money it costs. The money could be better spent on other school needs.

The benefits of passive solar

In addition to the obvious economic benefits of lower fuel and maintenance bills, reduced energy consumption, arising from passive solar design and energy efficiency improvement, has environmental benefits. Fossil fuel combustion is a major source of carbon dioxide emissions, which could result in significant change to global climates, and acid emissions to the atmosphere, which damage vegetation and can cause health problems.

Moreover, natural ventilation, daylight and sunlight (provided thought is given to preventing excessive unwanted solar gain) are very popular with pupils and teachers. Here is how one teacher described her passive solar designed school:

“The moment one walks in through the door and into the classroom, I enjoy being here. It’s not the sort of place that you feel at the end of the day you want to rush away from. New parents come in and say “Oh what a lovely room” because it is so nice to be able to look out. It’s a good environment, it’s good for us and I think it’s good for the children. It’s the sort of place that I would like to see children beginning school in. I think that even if we were in the centre of a city it would still be the same sort of warm friendly environment.”

Looe Junior School Teacher

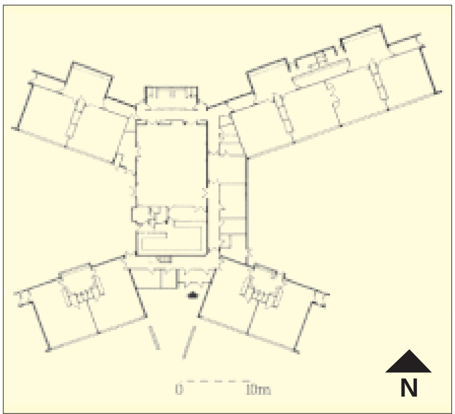
Surprisingly, such benefits can be achieved within normally accepted cost yardsticks. For example, Nabbotts School cost £381/m² compared with the average of £476/m² for primary schools in 1990. Looe School cost £417/m² which was close to the national average for its time of £398/m². The extra cost was due to a higher specification because of its exposed cliff top location. ETSU’s Passive Solar programme, funded by the DTI, has studied both Looe and Nabbotts School. Their results, and those for a school refurbishment, are described overleaf.

“...It’s a good environment; it’s good for us and... it’s good for the children”

ooe Primary School, Cornwall

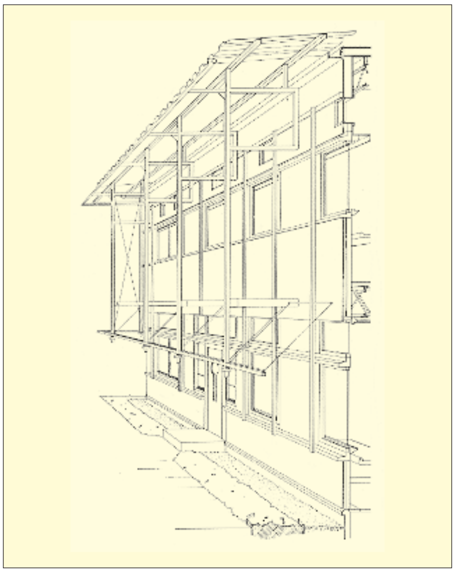
is is a new school for which solar energy pplies 25% of the heating. It is built on an posed south facing cliff top overlooking the a, and is well insulated and draught-proofed. e design maximises the amount of heat gain d daylight from the sun by putting classrooms th large windows on the south side and oakrooms and corridors at the rear along the lder north wall. North facing windows for ose areas are avoided by the provision of uth facing rooflights. Extra daylight for the ck of some classrooms comes from south cing light shafts through the roof space.

reduce overheating from summer sun, the ge south facing windows are shaded by the ep projection of the eaves of the roof and by ernal venetian blinds. The building also ores solar and other heat generated by pupils d lights within its 'heavyweight' construction ternal walls also concrete block), so that it sorbs excessive heat in the summer and the armed construction heats the air in the room er a long period in winter.



oe Primary School plan: arranged to aximise exposure to solar gains

verall the building is successful because the ality created by the passive solar design akes the building very attractive to work and because its primary energy need is 0 kWh/m^2, which betters a DFE target of 5 kWh/m^2 and makes it one of the better rforming low energy schools. The cost at 17/m^2 was only slightly above average spite high quality roof, windows and finishes.



Crookham: the 1960s school was refurbished to make it warmer in winter and cooler in summer

Crookham Junior School, Hants

This was a Mark I SCOLA prefabricated building of the 1960s in need of repair. It had a low level of insulation and draughts (due to badly fitting doors and windows), louvre windows and also lack of draught, lobbies. Most of the fabric was reclad, replaced and insulated. The amount of glazing was reduced with up to 75% of the upper clerestory windows and 30% of the remaining windows replaced with insulation panels. All windows were fitted with insulated shutters and the building was draught proofed.

To reduce overheating, fixed external sunshades of plastic netting were added, and a satisfactory daylight factor of 2% is still achieved at the rear of the rooms. Because the sunshades also sheltered the facade and so reduced maintenance costs, they were added to all elevations. North facing classrooms had rooflights added to boost daylight levels and introduce sunlight.

The combination of fabric redesign and installation of good heating controls has resulted in a warmer and more comfortable school. Furthermore, when open, the shutters create an inward sloping window reveal which enhances the quality of the daylight.

Nabbotts Junior School, Essex

The County's aim of making the best use of its prefabricated wall system and its wish to develop the use of courtyards, has been cleverly woven together by the designer into a design with considerable passive solar potential, although this was not the original aim. Two of the low cost rectangular buildings produced by the wall system were placed opposite each other to form a courtyard. The designer then realised that the school could be enhanced by the simple means of covering the courtyard with a transparent roof, thereby creating an atrium for use as a play and teaching space. Further developing the idea around cheap off-the-shelf components, he incorporated an openable swimming pool cover into the roof. The final design, shown in the sketch on the front page, has eight classrooms facing onto the atrium which teachers can choose to use by opening dividing doors.

Although the atrium is not heated, it is warmed by direct solar gains and heat from adjacent classrooms. Not only does this warming of the atrium mean that it can be used throughout the year, but also that the natural "stack effect" of buoyant warm air rising towards the atrium roof can be used to ventilate the building. By opening the electrically operated roof, the warm buoyant air can rise, drawing fresh air through classroom windows and ventilating the building. The covered courtyard provides additional circulation and teaching space. This, and the open plan teaching bays, make the school popular with the teachers.

Apart from passive solar considerations, the building has achieved a primary energy performance of 246 kWh/m^2 for the use of the building and atrium during normal school hours. This compares with the Audit Commission target of less than 250 kWh/m^2 for a good school. Its dual use as a school during the day and community centre in the evenings, weekends and holidays means that the building is heated for a longer than normal period each day. The atrium is therefore maintained by the heat losses at a higher temperature than it would otherwise be, which consequently means that it can be used almost continually throughout the year.

Lessons from these examples

Keep it simple: most of the positive solar benefits in new buildings come from attention o fundamentals such as orientation, form and ayout of rooms rather than any special alternative energy devices. It is also important o make the means of control easy to understand and use by staff and pupils.

ntegrate strategies: to get the most out of passive solar design it should be intergrated with other appropriate energy efficiency measures such as good insulation, draught proofing and controls on the heating system.

Balance strategies: particular energy aving features should not be pursued to the exclusion of other needs. For example, whilst a well draught proofed building may be very desirable, there must be adequate means of ventilation to reduce stuffiness, particularly in wet weather. A sensible scheme integrates all measures into a balanced cost-effective package.

Avoid conflicting strategies: different strategies can work on their own but can conflict when brought together. For example, a solar shading strategy may require the lowering of blinds which can then interfere with the flow of air from nearby windows needed for ventilation and also reduce daylight. The installation of rooflights to reduce electric light use can lead to increased heat loss unless the rooflights are well draught stripped and triple glazed.

Think far and wide: passive solar design has both energy saving and amenity benefits that last throughout the lifetime of a building and beyond the realms of energy savings. It should be remembered, when costing passive solar measures, that they may have a value that many other energy efficiency measures do not possess. Not only can they improve the comfort and energy performance of a school, they can also enhance the visual quality of classrooms and the character of the teaching that goes on within them.

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